

DOWNY MILDEW OF SUGARCANE

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Sugarcane (*Saccharum officinarum* L.), as an important world crop, is grown in tropical and subtropical regions of the world, and its history as "a honey-bearing reed" dates from 325 B.C. in Asia. It was introduced into Europe around 1000 A.D., grown in countries bordering on the Mediterranean in the 1300s, introduced into the Western Hemisphere (Dominican Republic) by Christopher Columbus, thence throughout the West Indies (Cuba in 1511), and into the United States (Louisiana) in 1751 (24).

Downy mildew of sugarcane was first described from Taiwan by Miyake in 1911, who ascribed *Sclerospora sacchari* as the causal agent, which has recently been changed to *Peronosclerospora sacchari* (T. Miyake) Shaw (26). The disease has been reported from the following countries: Australia, Fiji, India, Japan, New Guinea, Philippines, Taiwan, and Thailand (4,13); from Cuba (11), and with some question from Guatemala, Costa Rica, Honduras, Nicaragua, Panama, El Salvador (4), Peru (4,25), and Louisiana (USA) (4). The disease is of major importance in countries of the Eastern Hemisphere (10). Losses from downy mildew, also known as "leaf stripe", can range from 20 to 90 percent (16), with severe losses having been reported from Australia, Fiji, and Taiwan (10).

The host range of *P. sacchari*, besides sugarcane, includes corn, *Zea mays* L.; teosinte; *Zea mexicana* (Shrad.) Reeves & Mangleds.; *Euchlaena luxurians* Durieu & Aschers., (a large annual fodder grass); *Eleusine indica* (L.) Gaertn.; *Panicum purpurascens* Raddi

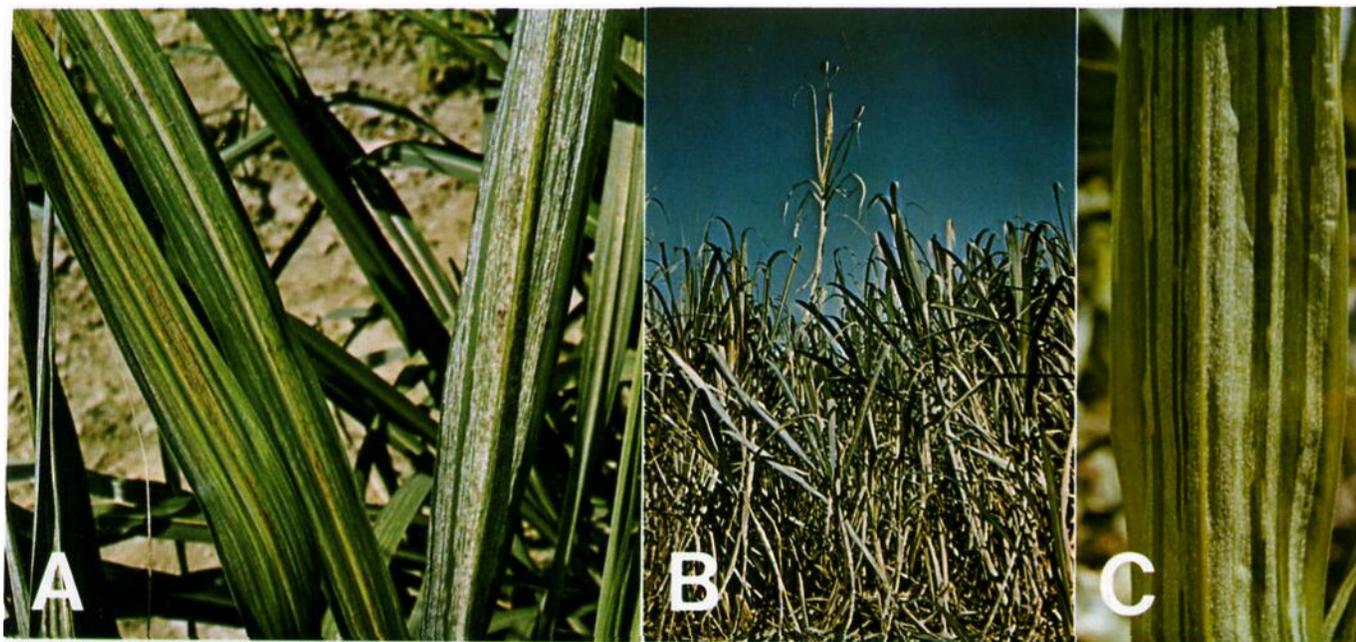


Fig. 1. Downy mildew of sugarcane: A) chlorotic stripes on leaves (courtesy of Dr. R. A. Fredericksen, Dept. Plant Science, Texas A & M Univ., College Station, TX); B) tall, spindly stalk rising above other stalks, "jump-up" cane (courtesy of Dr. Norman I. James, USDA, SEA, Beltsville, Maryland); C) velvety, white down of fungus on lower leaf surface (courtesy of Dr. A. J. Ullstrup, FFR Cooperative, West Lafayette, Indiana).

(*Panicum barbinode* Trin.); *Polypogon interruptus* HBK; *Saccharum barberi* Jeswiet; *S. robustum* Brandes & Jeswiet ex Grassl; *S. sinense* Roxb.; *Setaria verticillata* (L.) Beauv.; *Sorghum halepense* (L.) Pers.; *S. sudanense* (Piper) Stapf; *Sorghum bicolor* (L.) Moench (*S. vulgare* Pers.); and other cereals and grasses (10,13,14,20). *Sorghum* is not as susceptible as corn, and the fungus is variously reported to be nontransmissible (13) and transmissible (27) via the seed of corn.

The downy mildew fungus, *Peronosclerospora sacchari*, is an obligate parasite, as are all members of the genus, and as such must have a living host within which to reproduce and survive. The fungus is systemic in its host and grows intercellularly. Conidiophores (spore-bearing structures) emerge from the stomata of the host and are profuse on the lower leaf surface where stomata are more numerous (13,15). Greatest conidial production occurs at 22 to 25 C (72 to 77 F) at 95 percent relative humidity. They do not survive below 90 percent RH (13,17), and light inhibits or reduces sporulation (17).

The mildew is a fine white, soft velvety down of fungus growth when sporulating (Fig. 1-C), but appears as a fine powder under dry conditions. The conidia are colorless and are produced abundantly during warm, moist nights during the summer growing season. They are splashed on to healthy plants or carried by air currents for some distance, usually not more than 0.25 miles (400 meters) to favored infection sites of expanding buds and young leaf tissues still in the spindle (6,10,13). A single infected plant produces an estimated 5 to 10 billion spores in a single night (10,15). Sporulation has never been observed on mature leaves free of stripes and has never been found on any part of the sugarcane plant other than the leaf blade (13). Maximum disease spread thus occurs during the summer season when the cane growth is rapid, rains frequent and plentiful, and temperatures warm (13).

The sexual overwintering spore (oospore) develops in late autumn or winter in leaves that become shredded due to the numerous oospores within the mesophyll tissue between the vascular bundles. These spores are brown and easily detected with a hand lens (13). The exact role of oospores as overwintering (resting) spores is not known (10, 13), since efforts at host inoculation with oospores produced mixed results on disease establishment (13,18).

**SYMPTOMS:** The first symptoms resulting from infected seed cane are seen as emerging shoots that appear slightly pale green and lightly mottled, quickly followed by the production of downy mildew on the lower surface of the leaves. Stripes in these young leaves are poorly defined, but large areas may be involved. Such shoots usually never attain full development and sometimes die early. If they survive, the leaves are narrow, discolored, and upright in habit. Such shoots have thin stalks and are stunted, making them conspicuous (13).

Leaf symptoms on infected primary stalks usually occur 5 to 6 weeks after exposure to infection. Symptom expression can be delayed a few months due to the variety of cane, state of growth, and weather conditions. Initial symptoms are a slight paling and mottling at the base of the oldest spindle leaf as it lengthens and unrolls from the spindle, resembling the early stages of "pokkah boeng", caused by *Fusarium moniliforme* Sheld. (13). As the leaf expands, pale-green, longitudinal stripes (Fig. 1) develop at the base, extending 5 to 10 cm (2 to 4 inches) up the blade. The stripes lengthen somewhat as the leaf reaches its maximum size, but successive new leaves exhibit an increase in the length of the stripes, until practically the whole leaf area is involved. Leaf stripes frequently fuse at the base and become distinct and separate toward the leaf tip. Stripes have never been observed to develop initially on mature leaves (13).

Leaf stripes run parallel to the venation and are separated by normal green tissue of variable width, with edges becoming less well defined as the disease progresses.

Stripes are usually distributed across the entire width of the leaf, but on occasion may be confined to one-half of the blade. The number of stripes varies up to 30 to 40. Stripes do not occur on the leaf sheath, tend to be continuous, and generally 1 to 3 mm wide, but can be up to 10 mm wide on some susceptible varieties. In winter, susceptible varieties may produce very narrow leaf stripes and appear healthy when putting on new growth, but careful observation will often reveal a few short, inconspicuous stripes near the leaf base. With warmer conditions and resumption of active growth, characteristic leaf stripes are produced (13).

With increasing age, the color of the stripes changes from greenish yellow to a mottled reddish brown, and finally to a uniform dark red. Under favorable conditions the stripes tend to lose their regularity and fuse to form large, irregular, yellow or mottled red areas at the leaf tip. Often general discoloration occurs with the establishment of additional or secondary fungal invaders. Stalk infection that results in excessive stalk elongation is referred to as the "jump-up" phase of the disease (Fig. 1-B). These "jump-up" canes do not survive long and usually die by the end of winter. Infected stalks that are not greater in height than healthy ones, nevertheless appear spindly with discolored tops, having narrower erect leaves, which make them rather conspicuous (13).

Infection is not confined to primary stalks arising from plant cane or ratoon stool, but can also occur in secondary stalks and in late suckers. The symptoms are the same as on primary stalks, and such infected stalks can be of an important source of inoculum in the later stages of the crop, when perhaps the more obviously diseased stalks have been rogued (13).

**CONTROL:** Losses to the downy mildew disease of sugarcane can be mitigated, if not eradicated as occurred in India and Australia, by the following procedures: a) use of resistant varieties (9,10,13), since the losses to this disease are proportional to the susceptibility of the varieties grown (13); b) use of disease-free seed, i.e., planting seed cane from non-infested areas, as appropriately enforced by plant quarantine regulations through plant protection laws (1,2,3,5,7,10,12,13); c) frequent and careful roguing and destruction of infected stools (10,13,16,19,23) and complete plowing under of severely infested fields (23); d) isolation of cane plantings from downy mildew-susceptible corn and sorghum (9,10,16,21), since the disease is easily spread from corn to sugarcane and vice versa (21); e) hot-water treatment (immersion) of questionable seed cane for 1 hour at 45 C (113 F), dried for 24 hours at room temperature, then re-dipped for 1 hour at 52 C (126 F) or for 1 hour at 55 C (131 F), either method providing successful control and improved germination and growth rate. Chu (8) reported 75 to 100 percent healthy stools from seed cane pieces dipped in hot water for 1 hour at 52 C (126 F). Also planting of cane on well-drained land is encouraged (22).

**DETECTION AND SURVEY:** Look for 1) suspicious striping of leaves with evidence of downy mildew, soft and velvety or dried and powdery on the lower surface of leaves, 2) stunted, spindly stools with an upright habit of discolored leaves; 3) "jump-up" cane, where a single, spindly, brittle stalk with narrow leaves and discolored top appears taller than other stalks; 4) affected or abnormal-looking corn or teosinte (as well as other plants) which may serve as hosts, especially if located in close proximity (within 0.25 mile) to sugarcane; and 5) cane leaves that develop large, irregular, yellow or mottled red areas, which develop in advanced stages of downy mildew disease and not displaying the characteristic leaf stripes.

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